Drag race to Mars : The EDL of MSL

Or **Mars Curiosity Rover Engineering Design Challenge**

Adapted from Touchdown Challenge, nasa.gov/soi

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Description:
Students will design a capsule that will safely land the science payload (a marshmallow representing the Curiosity rover) following a drop test.

Objectives
Students will follow the engineering design process to:
• Design and construct a system out of paper, straws and miniature marshmallows to slow down the descent of the capsule, and allow for safe landing of the payload.
• Evaluate and improve their design based on testing results.

Grade Levels: 4-9

Connection To Curriculum/ Keywords :
Potential and Kinetic Energy, Acceleration Due to Gravity, Air Resistance (drag), Measurement**,** Newton's laws, engineering design process, Mars

National Science Education Standards, NSTA
Physical Science
• Properties of Objects and Materials.
• Position and Motion of Objects.
• Motion and Forces.

Science and Technology
• Abilities of Technological Design.

Common Core State Standards for Mathematics, NCTM
Measurement and Data
• Represent and interpret data.

ISTE NETS and Performance Indicators for Students, ISTE
Creativity and Innovation
Students:
• Apply existing knowledge to generate new ideas, products or processes.
• Create original works as a means of personal or group expression.
• Use models and simulations to explore complex systems and issues.
• Identify trends and forecast possibilities.

Critical Thinking, Problem Solving and Decision Making
Students:
• Identify and define authentic problems and significant questions for investigation.
• Plan and manage activities to develop a solution or complete a project.
• Collect and analyze data to identify solutions and/or make informed decisions.
• Use multiple processes and diverse perspectives to explore alternative solutions.

Teacher Prep Time: 15-30 Minutes

Materials needed (for each group) :
1 small paper or plastic cup (Styrofoam coffee cup works well)
3-5 index cards (3x5 and some 4x6 also)
1 regular-size marshmallow
6 miniature marshmallows
3 plastic straws
Scissors
Tape and Rubber Bands

Lesson Time Needed: 45 minutes

Lesson Activities and Sequence
1. **Engage**: Ask students what challenges are involved in landing a heavy object on a solid surface. Encourage discussion of physical forces involved: kinetic energy, acceleration due to gravity, transfer of energy upon impact. Allow students to experiment with air resistance (drag) by dropping paper helicopters (see attached template). Average drop speed can be calculated using the R=d/t equation. Include discussion of drag as related to automobiles and racing. Additional engagement activities: viewing the Seven Minutes of Terror video, and/or the video showing kinetic energy comparisons between MSL and race cars.
2. **Explore**: Students should work in cooperative groups to develop a design and use individual journals to record their decisions, design sketches, test results, etc. Each group should then build, test, evaluate and redesign their lander through several trials. Test data, observations, solutions, modifications, etc., should all be recorded in their journals individually.
3. **Explain**: Allow each group to share their lander and provide details of how they solved problems and revised their design throughout the engineering design process. Have students include related science concepts in their explanations and provide clarification and correction as necessary, and record these explanations in their journals.
4. **Extend**: How high can you go contest: Students drop their landers from 2 feet. Eliminate all landers that bounce out their “science payload.” Next, raise the height to 3 feet. Continue in this fashion until a winner emerges.
5. **Evaluation**: Using the students' journals, assess their mastery of content, skills and

the engineering design process.

DISCUSSION QUESTIONS

- What kind of air resistance can you create from these materials? Miniature marshmallows can serve as soft connectors. Cards can be used to create drag. Straws can provide a flexible structure. Rubber bands can flex and hold things together.

- How will you make sure the lander does not flip over as it falls through the air? Even distribute of the weight and the air resistance structure is critical for maintaining balance, and helps the lander fall straight down through the air.

- What forces affected your lander as it fell? It accelerated (sped up) as it fell due to the pull of gravity. Air also pushed on it, and this air resistance slowed it down.

- After testing, what changes did you make to your lander? Did your modifications improve the lander design and enable your design to meet the challenge? Answers will vary.

- Engineers' early ideas rarely work out perfectly. How does testing help them improve a design? Testing helps you see what works and what does not. Knowing this lets you improve a design by fixing the things that are not working well or could work even better.

- What did you learn from watching others test their landers? Answers will vary, but in general, kids will see that there are many ways to successfully tackle a challenge.

- Mars is covered in a thick layer of fine dust. How might this affect the lander? The lander's rocket engine could send up clouds of dust, which could get into the machinery and cause it to jam or malfunction. The surface is very dusty. Mars has the largest dust storms in the solar system.

- Mars has an atmosphere, but is very thin,100 times thinner than Earth's. How would this be an advantage? (There is some atmosphere to create air resistance and slow the lander down.) A disadvantage? (Not enough atmosphere to do the job well. Also, air resistance from the atmosphere that does exist generates friction and heat.)

- How would you assess the information gathered from MRO, and other NASA missions to identify selection of a landing site? Answers will vary. Encourage students to consider surface features and interesting geological features. Google Earth/ Mars comparison is an excellent supplemental resource for this investigation.

ASSESSMENT ACTIVITIES

Journaling is a valuable tool for engineers as they prepare and test designs to solve complex problems and meet challenges. Students should record their brainstorming session ideas, labeled and annotated sketches of their prototype designs, test results, modifications to their designs with sketches, photos, and group solutions that allow them to meet the challenge in a journal. They should also record any science, math, engineering, or technology content that is connected to their work or that they used to meet the challenge. The journal should be used as a formative and summative assessment tool.

ADDITIONAL RESOURCES

- Mars Exploration Program website: mars.jpl.nasa.gov
- Mars Reconnaissance Orbiter (MRO) Mission Page : http://www.nasa.gov/mission_pages/MRO/main/index.html
- Next Step Mars Module, NASA's Digital Learning Network (DLN): dln.nasa.gov
- Mars Curiosity Digital Badge activity: http://starlitebadges.com

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